

IS : 2131 - 1981
(Reaffirmed 1997)

Indian Standard

METHOD FOR STANDARD PENETRATION TEST FOR SOILS

(First Revision)

Third Reprint MARCH 1997

UDC 624.131.381

© Copyright 1982

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 3

February 1982

Indian Standard

METHOD FOR STANDARD PENETRATION TEST FOR SOILS

(First Revision)

Soil Engineering and Rock Mechanics Sectional Committee, BDC 23

Chairman

DR JAGDISH NARAIN

Representing

University of Roorkee, Roorkee

Members

ADDITIONAL DIRECTOR RESEARCH Ministry of Railways
(F. E.) RDSO

DEPUTY DIRECTOR RESEARCH

(SOIL-MECH) RDSO (*Alternate*)

SHRI P. D. AGARWAL Public Works Department, Government of Uttar
Pradesh, Lucknow

DR B. L. DHAWAN (*Alternate*)

DR ALAM SINGH

COL AVTAR SINGH

LT-COL V. K. KANITKAR (*Alternate*)

CHIEF ENGINEER (D&R)

University of Jodhpur, Jodhpur

Engineer-in-Chief's Branch, Army Headquarters

Irrigation Department, Government of Punjab,
Chandigarh

DR G. S. DHILLON (*Alternate*)

SHRI M. C. DANDAVATE

SHRI N. C. DUGGAL (*Alternate*)

SHRI A. G. DASTIDAR

The Concrete Association of India, Bombay

In personal capacity (5 Hungerford Street, 12/1,
Hungerford Court, Calcutta 700017)

Indian Geotechnical Society, New Delhi

Irrigation Department, Government of Uttar
Pradesh, Roorkee

Asia Foundations and Construction (P) Ltd,
Bombay

DR G. S. DHILLON
DIRECTOR, IRI

SHRI A. H. DIVANJI

SHRI A. N. JANGLE (*Alternate*)

DR GOPAL RAJAN

DR GOPAL RANJAN

SHRI S. GUPTA

Institution of Engineers (India), Calcutta

University of Roorkee, Roorkee

Cemindia Co Ltd, Bombay

SHRI N. V. DE SOUSA (*Alternate*)

SHRI G. S. JAIN

G. S. Jain & Associates, Roorkee

SHRI VIJAY K. JAIN (*Alternate*)

(Continued on page 2)

© Copyright 1982

BUREAU OF INDIAN STANDARDS

This publication is protected under the Indian Copyright Act (XIV of 1957) and
reproduction in whole or in part by any means except with written permission of the
publisher shall be deemed to be an infringement of copyright under the said Act.

(Continued from page 1)

<i>Members</i>	<i>Representing</i>
SHRI A. B. JOSHI DEPUTY DIRECTOR (CSMRS) (<i>Alternate</i>)	Central Water Commission, New Delhi
COL M. V. KAYERKAR SHRI V. B. GHORPADE (<i>Alternate</i>)	Ministry of Defence (R&D)
SHRI O. P. MALHOTRA	Public Works Department, Chandigarh Administration, Chandigarh
SHRI D. R. NARAHARI	Central Building Research Institute (CSIR), Roorkee
SHRI B. G. RAO (<i>Alternate</i>)	Central Road Research Institute, New Delhi
SHRI T. K. NATRAJAN	Indian Institute of Technology, New Delhi
DR G. V. RAO DR K. K. GUPTA (<i>Alternate</i>)	Public Works Department, Government of Punjab, Chandigarh
RESEARCH OFFICER (B&RRL)	Engineering Research Laboratories, Government of Andhra Pradesh, Hyderabad
SHRI K. R. SAXENA	Central Board of Irrigation & Power, New Delhi
SECRETARY DEPUTY SECRETARY (<i>Alternate</i>)	Roads Wing (Ministry of Shipping and Transport)
SHRI N. SIVAGURU	National Buildings Organization, New Delhi
SHRI D. V. SIKKA (<i>Alternate</i>)	Karnataka Engineering Research Station, Krishnarajasagar
SHRI K. S. SRINIVASAN SHRI SUNIL BERRY (<i>Alternate</i>)	Public Works Department, Government of Tamil Nadu, Madras
SHRI N. SUBRAMANYAM	EXECUTIVE ENGINEER (SMRD) (<i>Alternate</i>)
SUPERINTENDING ENGINEER (P&DC)	Director General, ISI (<i>Ex-officio Member</i>)
SHRI G. RAMAN, Director (Civ Engg)	<i>Secretary</i>
	SHRI K. M. MATHUR Deputy Director (Civ Engg), BIS

**The Site Exploration and Investigation for Foundation
Subcommittee, BDC 23 : 2**

<i>Members</i>	
SHRI V. S. AGGARWAL	Central Building Research Institute (CSIR), Roorkee
SHRI M. P. JAIN (<i>Alternate</i>)	University of Jodhpur, Jodhpur
DR ALAM SINGH DEPUTY DIRECTOR RESEARCH (PE), RDSO	Ministry of Railways
ASSISTANT DIRECTOR RESEARCH (SOIL MECH) RDSO (<i>Alternate</i>)	Central Water Commission, New Delhi
DIRECTOR (CSMRS)	
DEPUTY DIRECTOR (CSMRS) (<i>Alternate</i>)	

(Continued on page 10)

Indian Standard
METHOD FOR STANDARD
PENETRATION TEST FOR SOILS
(*First Revision*)

0. F O R E W O R D

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 24 December 1981, after the draft finalized by the Soil Engineering and Rock Mechanics Sectional Committee had been approved by the Building Division Council.

0.2 Standard penetration test conducted by means of the split spoon, specified in this standard, furnishes data about resistance of the soils to penetration which can be used to evaluate standard strength data, such as N values (number of blows per 30 cm of penetration using standard split spoon) of the soil. Methods of calculation of bearing capacity of soils based on N values are covered in IS : 6403-1981*. For obtaining dependable and reproducible samples, a standard procedure is necessary and this code is intended to furnish necessary guidance to the soil explorer in this regard.

0.3 This standard was first published in year 1963 and this revision has been done so as to include a standardized split spoon sampler for which a detailed specification has been formulated separately, besides including the details of the correction factors which are necessary in calculation of bearing capacity.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies a standard procedure for conducting the standard penetration test for soils.

*Code of practice for determination of bearing capacity of soils (*first revision*).

†Rules for rounding off numerical values (*revised*).

2. EQUIPMENT

2.1 Drilling Equipment

2.1.1 The equipment used shall provide a clean borehole, 100 to 150 mm in diameter, for insertion of the sampler to ensure that the penetration test is performed on undisturbed soil and shall permit driving of the split spoon sampler to obtain penetration record and the sample in accordance with the procedure specified in 3.

Note — The stiffness of the drill rod used for testing influences the N value obtained by means of the test. A light rod 'whips' under the blows of the hammer. The drill rod shall preferably have a stiffness equal to A-rod (41.3 mm outer diameter). For depths of exploration more than 10 m, special precautions shall be taken to keep the rod vertical by using centering spacers and/or by using stiffer rods to minimize the whipping effect. Spacers may be provided at every 10 m, or more frequently, if necessary.

2.1.2 Casing or Drilling Mud — It shall be used when drilling in sand, soft clay or other soils in which the sides of borehole are likely to cave in. In sandy and other non-cohesive soils, below water table it is often preferable to use drilling mud rather than a casing. If drilling mud alone is not successful, casing may be used along with the drilling mud.

2.2 Split-Spoon Sampler — The split spoon sampler shall conform to IS : 9640-1980*.

2.3 Drive Weight Assembly

2.3.1 The drive weight assembly shall consist of a driving head and a 63.5 kg weight with 75 cm free fall. It shall be ensured that the energy of the falling weight is not reduced by friction between the drive weight and the guides or between rope and winch drum.

2.3.2 The rods to which the sampler is attached for driving should be straight, tightly coupled and straight in alignment. For driving the casing, a hammer heavier than 63.5 kg may be used.

2.4 Lifting Bail, Tongs, Rope, Screw Jack etc

3. PROCEDURE

3.1 Driving the Casing — Where casing is used, it shall not be driven below the level at which the test is made or soil sample is taken. In the case of cohesionless soils which cannot stand without casing, the advancement of the casing pipe should be such that it does not disturb the soil to be tested or sampled; the casing shall preferably be advanced by

*Specification for split spoon sampler.

slowly turning the casing rather than by driving, as the vibration caused by driving may alter the density of such deposits immediately below the bottom of the borehole.

3.2 Cleaning the Borehole

3.2.1 In case wash boring is adopted for cleaning the borehole, side-discharge bits are permissible, but in no case shall a bottom-discharge bit be permitted. The process of jutting through an open tube sampler, and then testing and sampling when the desired depth is reached shall not be permitted.

3.2.2 While boring through soils, such as sands that may be disturbed by the flow of water into the drill hole, no water shall be added to the borehole while boring above the water table. While boring below water table, the water in the borehole shall be maintained at least 1·5 m above the level of the water table. Bentonite slurry of appropriate consistency may be required to help the water level to be maintained above the water table. The raised level of the water in the borehole should be maintained even if casing is used to stabilize the borehole.

3.2.2.1 While boring through sand using casing to stabilize the sides of the borehole, the outer diameter of the shell shall be at least 25 mm smaller than the inner diameter of the casing. The distance between the end of the casing and the bottom of the borehole should be as close as possible and in any case not exceed 150 mm, if only water is used to stabilize the borehole; in case bentonite is used, this distance may be up to 300 mm.

3.2.3 The borehole shall be cleaned up to testing or sampling elevation, using suitable tools, such as augers, that will ensure that there is minimum mixing up of the soil from the bottom of the borehole. In cohesive soils, the borehole may be cleaned with bailer with a flap valve. This should not be used in sands.

3.3 Obtaining the Samples

3.3.1 Tests shall be made at every change in stratum or at intervals of not more than 1·5 m whichever is less. Tests may be made at lesser intervals if specified or considered necessary. The intervals be increased to 3 m if in between vane shear test is performed.

3.3.2 The sampler shall be lowered to the bottom of the borehole. The following information shall be noted and recorded:

- a) Depth of bottom of borehole below ground level,
- b) Penetration of the sampler into the soil under the combined weight of sampler and rods (to be noted from readings of the scale over the drill rod at the top),

- c) Water level in the borehole or casing, and
- d) Depth of bottom of casing below ground level.

3.3.3 The split spoon sampler resting on the bottom of borehole should be allowed to sink under its own weight; then the split spoon sampler shall be seated 15 cm with the blows of the hammer falling through 75 cm. Thereafter, the split spoon sampler shall be further driven by 30 cm or 50 blows (except that driving shall cease before the split spoon sampler is full). The number of blows required to effect each 15 cm of penetration shall be recorded. The first 15 cm of drive may be considered to be seating drive. The total blows required for the second and third 15 cm of penetration shall be termed the penetration resistance N ; if the split spoon sampler is driven less than 45 cm (total), then the penetration resistance shall be for the last 30 cm of penetration (if less than 30 cm is penetrated, the logs should state the number of blows and the depth penetrated).

3.3.3.1 The entire sampler may sometimes sink under its own weight when very soft sub-soil stratum is encountered. Under such conditions, it may not be necessary to give any blow to the split spoon sampler and SPT value should be indicated as zero.

3.3.4 If on lowering the sampler by means of a string of rods it is found to rest at a level above the bottom of the casing, the penetration test and sampling should not be carried out at that stratum.

3.4 Removal of Sampler and Labelling

3.4.1 The sampler shall be raised to the surface and opened. A typical sample or samples of soil from the opened split spoon shall be put into jars without ramming. The jars shall have a self-sealing top, or shall be sealed with wax to prevent evaporation of the soil moisture. Jars shall be of such a size that they can be filled without deforming the sample. Typical samples shall be cut to such a size as to fill the jars and thereby reduce the water loss to the air in the jars. If packing as specified is not available, liner may be used in the sampling spoon. In such a case, the internal diameter of the sampling spoon should be so adjusted that the total internal diameter after incorporating the liner is 35 mm. The sample in the liner shall be waxed properly at both the ends to keep up the natural moisture content during transit.

3.4.2 Labels shall be fixed to the jar or notations shall be written on the covers (or both) with the following information:

- a) Origin of sample,
- b) Job designation,

- c) Boring number,
- d) Sample number,
- e) Depth of sampling,
- f) Penetration record,
- g) Length of recovery, and
- h) Date of sampling.

3.4.3 The jars containing samples shall be stored in suitable containers for shipment. Samples shall not be placed in the sun.

3.5 Field Observations

3.5.1 Information with regard to water table, elevations at which the drilling water was lost or elevations at which water under excess pressure was encountered shall be recorded on the field logs. Water levels before and after putting the casing, where used, shall be measured. In sands, the level shall be determined as the casing is pulled and then measured at least 30 min after the casing is pulled; in silts, at least 24 h after the casing is pulled; in clays, no accurate water level determination is possible unless pervious seams are present. However, the 24 h level shall be recorded for clays. When drilling mud is used and the water level is desired, casing perforated at the lower end shall be lowered into the borehole and the borehole bailed down. Ground water levels shall be determined after bailing at time intervals of 30 min and 24 h until all traces of drilling mud are removed from inside the casing.

3.6 Corrections

3.6.1 Due to Overburden — The N value for cohesionless soil shall be corrected for overburden as per Fig. 1 (N').

3.6.2 Due to Dilatancy — The value obtained in **3.6.1** shall be corrected for dilatancy if the stratum consists of fine sand and silt below water table for values of N' greater than 15, as under (N''):

$$N'' = 15 + \frac{1}{2} (N' - 15)$$

4. REPORT

4.1 Data obtained in borings shall be recorded in the field and shall include the following:

- a) Date of boring,
- b) Reference datum,
- c) Job identification,

- d) Boring number,
- e) Sample number,
- f) Type of sampler,
- g) Drilling method,
- h) Sample elevation and recovery ratio,
- j) Limits of stratum,
- k) Water table information (*see 3.5*),
- m) Soil identification, including condition of samples,
- n) Penetration records,
- p) Casing used, and
- q) Weather data.

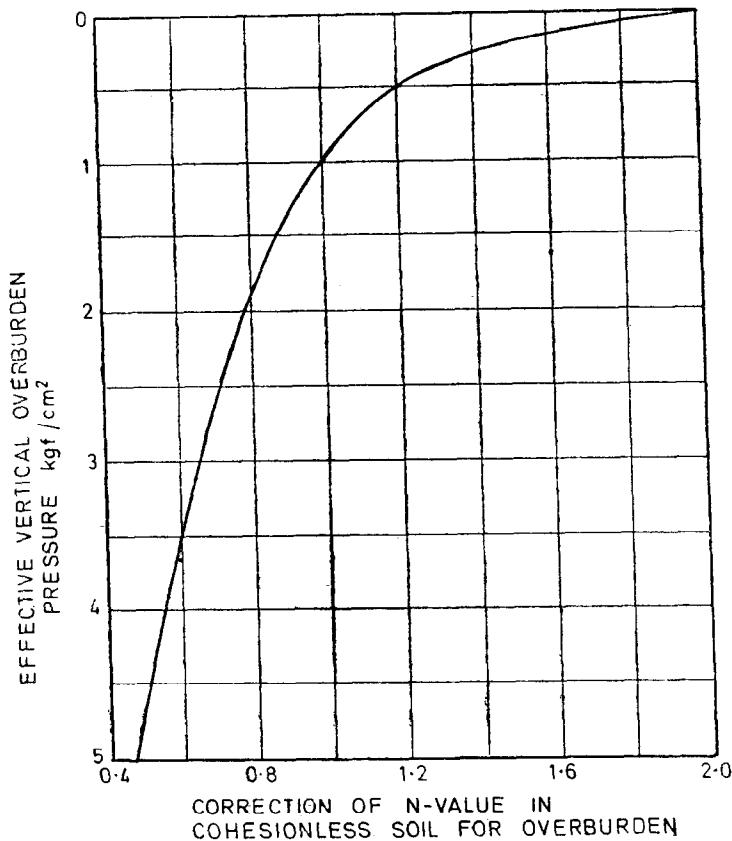


FIG. 1 CORRECTION DUE TO OVERBURDEN

4.2 The data obtained shall be prepared in a final form as a soil profile to show the nature and extent of the soil strata over the area under consideration.

(Continued from page 2)

<i>Members</i>	<i>Representing</i>
DIRECTOR, PWDRI	Public Works Department, Government of Uttar Pradesh, Lucknow
EXECUTIVE ENGINEER (DESIGN)V	Central Public Works Department, New Delhi
EXECUTIVE ENGINEER (SMRD)	Public Works Department, Government of Tamil Nadu, Madras
EXECUTIVE ENGINEER (CD) (<i>Alternate</i>)	
SHRI M. D. NAIR	Associated Instruments Manufacturers (India) Private Ltd, New Delhi
PROF T. S. NAGARAJ (<i>Alternate</i>)	
SHRI T. K. NATRAJAN	Central Road Research Institute, New Delhi
LT-COL K. M. S. SAHASI	Engineer-in-Chief's Branch, New Delhi
SHRI A. K. CHATURVEDI (<i>Alternate</i>)	
SHRI S. K. SHOME	Geological Survey of India, Calcutta
SHRI P. N. MEHTA (<i>Alternate</i>)	
SHRI N. SIVAGURU	Roads Wing, Ministry of Transport
SHRI P. K. THOMAS (<i>Alternate</i>)	
SUPERINTENDING ENGINEER (IP), NAGPUR	Irrigation Department, Government of Maharashtra, Bombay

